Appendix C – Line Separation Issue Paper

Line Separation

Background

While it is generally desirable to build lines on the same corridor side by side for environmental and land use reasons, the likelihood and consequences of outage of two or more lines due to a common event must be considered by transmission planners. The loss of multiple circuits into a load area will result in increased demand over the remaining circuits and can result in area blackout unless load and/or generation (sometimes a sizable amount) is tripped off to balance flow with remaining transmission capacity. Transmission planning is done on the basis of *not* interrupting customer load for the more common system transmission line outage events since high voltage grid interruptions have the potential of affecting a large number of customers and critical load such as hospitals, emergency services and other essential or sensitive loads.

The Western Systems Coordinating Council (WSCC), the reliability council for the Western US of which BPA is a member, has established performance criteria applicable to loss of multiple lines. In the case of the more likely multi-contingency events (loss of two lines or all lines in a corridor) standards exist related to allowed electrical performance as well as admissible countermeasures such as load or generator tripping. Successive loss of transmission lines and attendant load and generation, like falling dominos (called "cascading") is not allowed. In the case of even less likely events (sometimes called unplanned or extreme events) reliance is placed on containment measures such as load shedding, system islanding (separating areas of the system from one another) and other means to limit cascading.

Some pertinent parts of the reliability criteria dealing with multiple line or rights of way outages are provided in Attachment 1. Simultaneous loss of two or more lines built on the same rights of way is considered to be a likely (credible) event. Simultaneous loss of two or more lines built on separate rights of way is generally considered to be a non-credible event. Provision has been made for specific cases to classify loss of two lines on the same rights of way as a non-credible event based on line design; length; location, whether forested, agricultural, mountainous, etc; outage history; operational guidelines; and separation between circuits. A WSCC recently approved method would allow loss of two lines on the same rights of way to be classified as non-credible if the estimated frequency of occurrence (mean time between failure) is greater than 300 years. However, the latter is very difficult to demonstrate and would generally be limited to lines that are on the same rights of way for short distances. Work is continuing to also

consider impact and exposure (percentage of time the system would be in an at-risk condition).

Line Spacing Requirements

There is not any single criteria or rule that establishes minimum circuit spacing requirements to qualify as very low likelihood (not credible) since the importance of various risk factors are not the same in all cases. However, cases within WSCC of minimum separation of 2000 feet have been accepted as not credible. The following list represent risks that are mitigated by line separation. To the extent that these can be mitigated by design or maintenance measures the need for separation may be reduced.

1. One tower falling into an adjacent line
2. A snagged shield wire from one line being dragged into the adjacent line (span length)
3. An aircraft flying into more than one circuit
4. Fire on the right of way or smoke (ionized particles) enveloping more than one circuit causing temporary failure
5. Lightning strokes affecting more than one line.

The risk of fire or smoke affecting two lines can be managed by rights of way maintenance practices and notification procedures. Increased spacing reduces the risk that multiple circuits will be affected and increases time for notification and corrective dispatcher action. Terrain is important in terms of the amount and volatility of combustible materials.

The risk of lightning caused events can be mitigated by the use of shield wires (a target instead of the energized conductors), and by modifying protective control circuits (relaying).

Risks 1-3 are generally mitigated by increased spacing between lines. As noted in Attachment 1 under the definition of *Three or More Circuits in a Right-of-Way* " some organizations use separation by more than the span length as adequate to designate the circuits as being in separate corridors." Span lengths for 500 kV lines are typically 1000 to 1500 feet depending on terrain.

When Is Corridor Separation Needed?

As noted, the NERC/WSCC Planning Standards make allowance for mitigating action for multi-contingency outages affecting lines on the same rights of way. However, it is BPA and general utility practice that two-line outages should *not* rely on interruption of customer load except for very

unusual operating conditions such as adverse cold weather, or a weakened transmission system. Generator tripping may be used as a countermeasure in some cases for two-line outages but it also becomes objectionable if the requirements are excessive or impractical.

Summary - As a matter of practice, construction on separate rights-of-way is necessary when a multi-circuit outage on a common corridor must be considered a credible event and corrective action for this outage would require excessive or impractical countermeasures.

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Attachment 1 Citations from WSCC Reliability Criteria Documents

Western Systems Coordinating Council (WSCC) – organized in 1967 to be the regional forum for actively promoting regional electric service reliability through the development of planning and operating reliability criteria and policies; the monitoring of compliance with these criteria and policies; and the facilitation of a regional transmission planning process. It consists of 98 members, 10 affiliate members, and 7 commission members spanning the Western US and parts of Canada and Mexico.

WSCC-S2 *"The loss of three or more circuits on a common right of way shall not result in cascading".[1, page_]*

WSCC-S3 *"The common mode simultaneous outage of … two circuits shall meet the performance specified for Category C of the WSCC Disturbance Performance Table…" [1, page _]*

Simultaneous Outage *"Multiple outages are considered to be simultaneous if the outages subsequent to the first event occur before manual readjustment can be made." [2]*

Three or More Circuits in a Right of Way
"In the application of WSCC-S2, loss of three or more circuits on a common right of way is intended to cover those situations where the separation between circuits is such that a common mode failure could result in the simultaneous outage of multiple circuits. The credibility of such an outage depends on the credibility of the common mode failure. Considerations in the determination of credibility should include line design; length; location, whether forested, agricultural, mountainous, etc.; outage history; operational guidelines; and separation between circuits. For example, some organizations use separation by more than the span length as adequate to designate the circuits as being in separate corridors."[1, page_]

Two Circuits
"In the application of WSCC-S3, loss of two circuits is intended to cover those situations where a common mode failure could result in the simultaneous loss of two circuits. The credibility of such an outage depends upon the credibility of the common mode failure. The credible outage of two circuits could result from a lightning storm or forest fire. Loss of two circuits does not require the same tower or right of way to be credible. Consideration in the determination of credibility should include line design; length; location, whether forested, agricultural, mountainous, etc,; outage history; operational guidelines; and separation between circuits."[1, page_]

Cascading

References

[1] NERC/WSCC Planning Standards, date.

[2]WSCC Reliability Criteria, August 2000, Part IV, page 7.